HARDING-LAWSON ASSOCIATES

FOUNDATION INVESTIGATION
MILILANI INTERMEDIATE AND
HIGH SCHOOL, SECOND INCREMENT
MILILANI TOWN, OAHU, HAWAII

H-LA Job No. 3911,011.06

Prepared for

State of Hawaii
Department of Accounting and General Services
Division of Public Works
P. O. Box 119
Honolulu, Hawaii 96810

by

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May 15, 1973

INTRODUCTION

This report presents the results of our foundation investigation for the proposed second increment of the Mililani Intermediate and High School in Mililani Town, Oahu, Hawaii. The site is located on Kipapa Drive and is bounded on the north by Hookelewaa Street and on the south and east by the proposed Moheula Parkway. The site configuration and building locations are shown on the Site Plan, Plate 1.

The planned second increment will include three buildings: the Fine Arts Center, the Library and Instructional Center, and the Kitchen and Multipurpose Center. The Fine Arts Center will be a two-story, reinforced concrete building with a slab-on-grade bottom floor. Structural loads will be carried by columns and bearing walls. Dead plus live loads will range up to 169 kips for the columns and 7.4 kips per lineal foot for the walls. The library and kitchen facilities will be one-story high with reinforced concrete columns, concrete block walls and steel trusses for roof support. Structural dead plus live loads will range up to 69 kips for columns and 4.5 kips per lineal foot for bearing walls.

Planned grading in the new building areas will include cuts up to 4-1/2 feet deep. Fill will not be required in the building areas and excavated material will be used between the buildings or will be stockpiled for latter use elsewhere on the site.

The scope of our work was to explore subsurface conditions at the site in order to develop conclusions and recommendations regarding

1. Site preparation and grading including the suitability of on-site material for compacted fill and required degree of compaction
2. Suitable foundation types for the buildings and soil criteria necessary for foundation design
3. Settlement behavior of foundations
4. Slab-on-grade floor support

Our work was authorized by your letter dated March 1, 1973.

FIELD EXPLORATION AND LABORATORY TESTS

We explored subsurface conditions in the proposed new building areas by drilling seven test borings, 14 to 29 feet deep, with truck-mounted, flight auger drilling equipment. The borings were logged by our field engineer who obtained core samples from them for examination and laboratory tests. The boring locations are shown on Plate 1. The Boring Logs are presented on Plates 2 through 8. The borings are numbered consecutively starting with boring no. 8; borings 1 through 7 were drilled by Harding-Lawson Associates during the foundation investigation for the first increment. The soils are classified in accordance with the Unified Soil Classification System, Plate 9.

Our laboratory testing program included moisture content/dry density determinations, triaxial strength tests, a consolidation test and Atterberg Limits determinations. The

consolidation test data are presented on Plate 10. The Atterberg Limits test results are summarized on the Plasticity Chart, Plate 11. The remaining test data are presented on the boring logs in the manner described by the Key to Test Data, Plate 9.

SITE AND SOIL CONDITIONS

The proposed buildings are located in the north portion of the school site in relatively level to gently sloping areas. The area around the fine arts building has been cleared to provide access for the construction of the adjacent Math/Science Center. The library and kitchen buildings are partially situated in an old pineapple field and the surface is covered with thick grass and occasional pineapple plants.

The site is underlain by stiff, clayey silt residual soil to the depths explored (14 to 29 feet). The soil is strong, relatively incompressible and appears to be slightly expansive. The soil conditions appear to be uniform throughout the areas explored.

Free water was not encountered in the test borings.

CONCLUSIONS

Our investigation indicates that there will be no unusual foundation or grading problems at the site and that the planned buildings can be supported on shallow spread footings.

Foundation settlements for spread footings bottomed in stiff, natural soil will be less than 1/2 inch. Differential settlements between adjacent columns and bearing walls will be less than 1/4 inch.

Excavations can be made with conventional, medium-duty, earth-moving equipment. The excavated soil will be suitable for reuse as compacted fill.

The on-site soils are moderately expansive and special treatment will be required to reduce shrinking and swelling. Subgrade surfaces and footing excavations should be maintained in a moist condition until slabs, pavements and footings are placed. The upper 18 inches of fill should be compacted wet of the optimum moisture content*.

RECOMMENDATIONS

Site Preparation and Grading

Grass and vegetation, along with the upper two or three inches of soil containing roots and organic matter, should be stripped from the areas to be graded. Surfaces to receive fill should be scarified to a depth of eight inches, moisture conditioned to a moisture content suitable for compaction and

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* Optimum moisture is that moisture content which corresponds to the maximum dry density as determined by the ASTM D1557-70(C) compaction test method.

compacted to 90 percent relative compaction*.

Fill material should be placed in eight inch lifts, moisture conditioned and compacted to at least 90 percent relative compaction. The top 18 inches of fill should be compacted wet of the optimum moisture content where surface improvements such as pavements or slabs are planned.

Cut and fill slopes should be graded no steeper than two horizontal to one vertical. Surface water should be diverted away from the slopes and slopes should be planted to retard erosion.

Foundation Support

Spread footings can be designed according to the following criteria:

Bearing Pressures

Dead Loads.....	3,500 psf
Total design loads, including wind and seismic forces.....	5,000 psf

Resistance to Lateral Loads

Friction on the bottom of the footings (times vertical dead loads).....	0.4
Passive soil resistance (due to stiff natural soil on the face of footings).....	2,000 psf*

*Where footings are not confined on all sides by slabs or pavements, passive resistance in the top foot should be neglected.

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*Relative compaction refers to the dry density of the compacted material expressed as a percentage of the maximum dry density of the same material determined by the ASTM D1557-70(C) test procedure.

Footings should be at least 12 inches wide and should be bottomed at least 18 inches below lowest adjacent finished grade on stiff natural soil.

Slab-on-Grade Floors

Subgrade for slab floors should be rolled to provide a uniformly dense, nonyielding surface. The subgrade surface should be maintained in a moist condition until the floor is constructed. Slab floors should be underlain by at least four inches of free-draining, crushed rock to provide a capillary moisture break. The rock should conform to the following gradation:

Sieve Size	Percent Passing
1-1/2 inches	90 - 100
No. 4	0 - 5
No. 200	0 - 3

Locally available material, commercially designated as 3B-Fine, will meet this gradation.

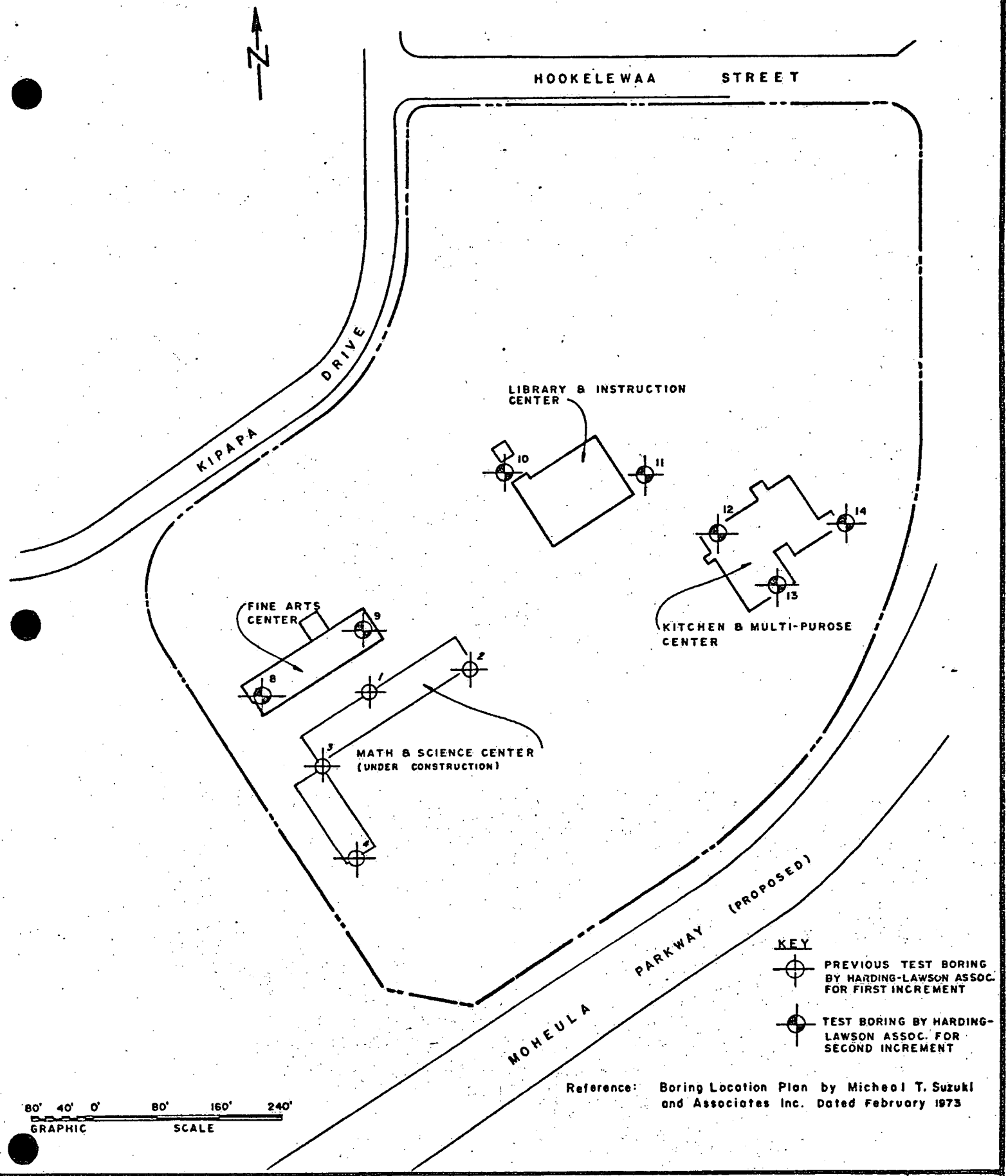
An impervious membrane should be installed between the crushed rock and concrete slab in areas where penetration of moisture vapor through the floor would be ojectionable.

Review of Plans

We should review the grading and foundation plans when they are completed to verify that they comply with the intent of our recommendations.

PLATES

Plate	1	Site Plan
Plates through	2 8	Logs of Borings 8 through 14
Plate	9	Soil Classification Chart and Key to Test Data
Plate	10	Consolidation Test Report
Plate	11	Plasticity Chart



Reference: Boring Location Plan by Michael T. Suzuki and Associates Inc. Dated February 1973

Job No. 3911.011.06
Designed ——
Drawn E.J.H
Checked D.G.G.
Approved D.G.G.
Date 4-26-73
Scale 1" = 80'

HARDING, MILLER, LAWSON & ASSOCIATES
Consulting Engineers

SITE PLAN

MILILANI INTERMEDIATE AND HIGH SCHOOL

SECOND INCREMENT

MILILANI TOWN OAHU HAWAII

PLATE 1

LOG OF BORING 8 (1)

Equipment Flight Auger

Elevation 732 (2) Date 4/11/73

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot (3)	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample
			148	28.0	91	0	
			74	35.8	85	5	
			42	36.4	86	10	
CONSOL			33			15	
			30	44.4	78	20	
			30	43.6	78	25	
						30	
						35	
						40	

RED-BROWN CLAYEY SILT (MH)
stiff, dry
very stiff and moist at 2'

brown at 14'

stiff and wet from 15'

(no free water encountered)

(1) Borings 1 through 7 were drilled during First Increment soil investigation

(2) Master Plan datum

(3) Blow counts converted to Standard Penetration Test values

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LOG OF BORING 8

Mililani Intermediate and High School, Second Increment
Mililani Town, Oahu, Hawaii

PLATE 2

ELEV 732

LOG OF BORING 9

Equipment Flight Auger

Elevation 733 Date 4/11/73

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample	
			70	22.7		0		RED-BROWN CLAYEY SILT (MH) very stiff, dry
								moist at 3'
TX 7000(1000)			61	36.2	85	5		
						10		
			19					becoming brown with occasional grey-brown zones
						15		
TX 1580(1600)			43	39.0	82			wet at 15'
						20		
			24					
			31			25		(no free water encountered)
						30		
						35		
						40		

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LOG OF BORING 9
Mililani Intermediate and High School, Second Increment
Mililani Town, Oahu, Hawaii

PLATE 3

LOG OF BORING 10

Equipment Flight Auger

Elevation 733 Date 4/11/73

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample
						0	RED-BROWN CLAYEY SILT (MH) stiff, moist very stiff at 2'
TX 3380(1000)			55	30.1	92		
			75	27.4	98	5	
			111			10	
			46			15	brown at 15'
			70			20	
			23			25	(no free water encountered)
						30	
						35	
						40	

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LOG OF BORING 10
Mililani Intermediate and High School, Second Increment
Mililani Town, Oahu, Hawaii

PLATE 4

LOG OF BORING II

Equipment Flight Auger

Elevation 733 Date 4/12/73

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample
LL 64 PI 29			46			0	
TX 2580(1000)			54	32.1	92	5	
			56	34.3	90	10	
			80			15	
						20	
						25	
						30	
						35	
						40	

RED CLAYEY SILT (MH)
very stiff, dry
moist at 2'

brown at 6'

(no free water encountered)

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LOG OF BORING II
Mililani Intermediate and High School, Second Increment
Mililani Town, Oahu, Hawaii

PLATE 5

LOG OF BORING 12

Equipment Flight Auger

Elevation 735 Date 4/12/73

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample	
						0		RED CLAYEY SILT (MH) moderately stiff, dry
TX 7430(1000)			47	32.2	94			very stiff and moist at 1.5'
			45	28.4	99	5		brown at 7'
			46	33.6	92	10		
			50	38.0	86	15		wet at 15'
			55			20		
			11			25		stiff from 25'
			17	55.0	69	30		(no free water encountered)
						35		
						40		

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LOG OF BORING 12

Mililani Intermediate and High School, Second Increment

Mililani Town, Oahu, Hawaii

PLATE 6

LOG OF BORING 13

Equipment Flight Auger

Elevation 736 Date 4/12/73

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample
						0	
			47			5	
			57			10	
			71			15	
			45			20	
						25	
						30	
						35	
						40	

RED-BROWN CLAYEY SILT (MH)
moderately stiff, dry
very stiff and moist at 1.5'

(no free water encountered)

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LOG OF BORING 13
Mililani Intermediate and High School, Second Increment
Mililani Town, Oahu, Hawaii

PLATE 7

RF 14

LOG OF BORING 14

Equipment Flight Auger

Elevation 733 Date 4/12/73

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample
						0	
			50				
			76			5	
						10	
TX 3160(1000)			34	33.2	90		
						15	
						20	
						25	
						30	
						35	
						40	

RED-BROWN CLAYEY SILT (MH)
very stiff, moist

with brown mottling from 5'

(no free water encountered)

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LOG OF BORING 14
Mililani Intermediate and High School, Second Increment
Mililani Town, Oahu, Hawaii

PLATE 8

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAN #200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN #200 SIEVE)	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

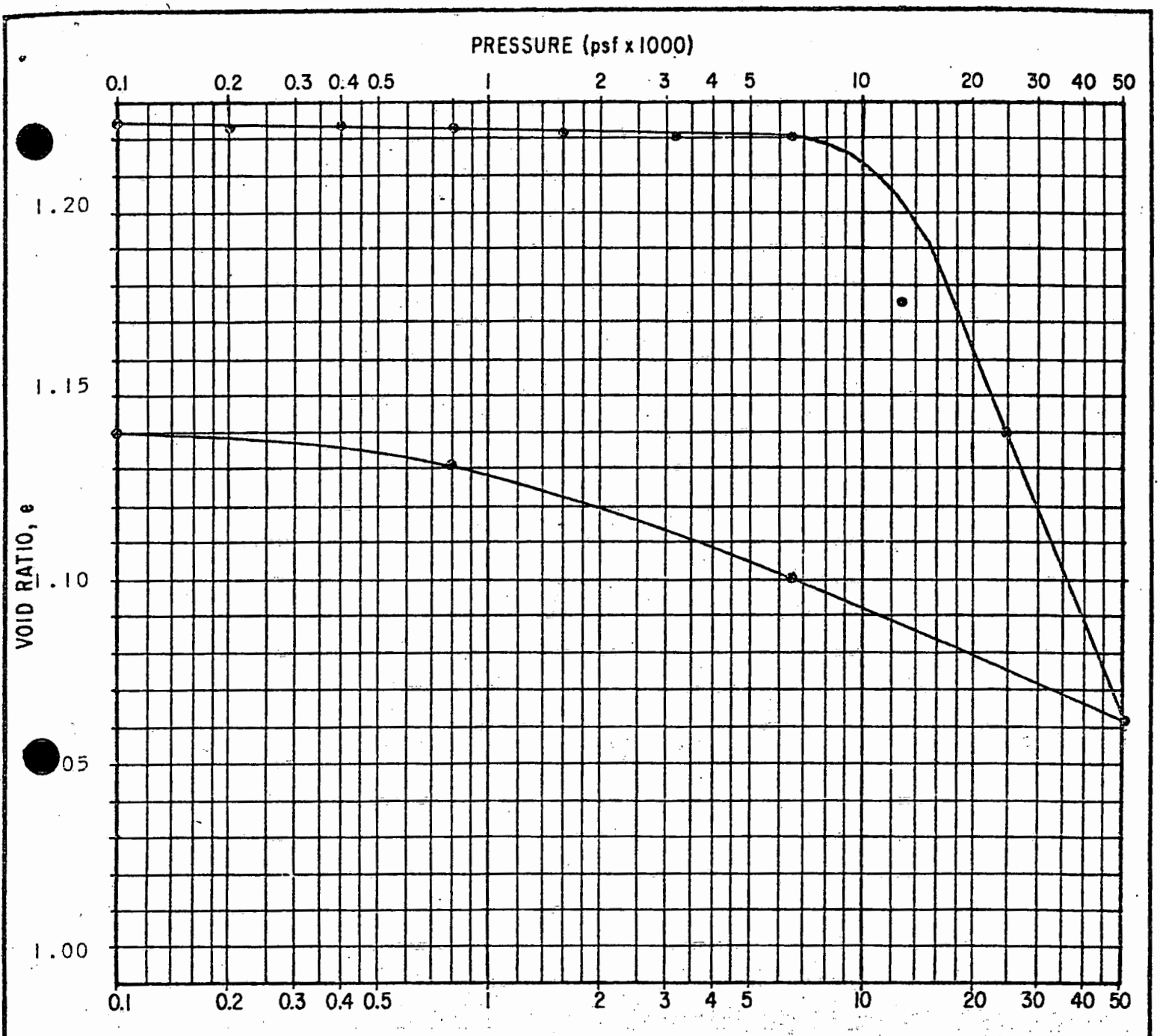
Consol — Consolidation
LL — Liquid Limit (In %)
PL — Plastic Limit (In %)
G_s — Specific Gravity
SA — Sieve Analysis
▩ "Undisturbed" Sample
⊠ Bulk Sample

	Shear Strength, psf	Confining Pressure, psf	
*Tx	320	(2600)	Unconsolidated Undrained Triaxial
TxCU	320	(2600)	Consolidated Undrained Triaxial
DS	2750	(2000)	Consolidated Drained Direct Shear
FVS	470		Field Vane Shear
*UC	2000		Unconfined Compression
LVS	700		Laboratory Vane Shear

Notes: (1) All strength tests on 2.8" or 2.4" diameter samples unless otherwise indicated.

(2) * indicates 1.4" diameter sample.

KEY TO TEST DATA



Type of Specimen			Before Test			After Test	
Diameter (in.) 2.43	Height (in.) 0.80		Moisture Content	w_o	46.4 %	w_f	45.5 %
Overburden Press., P_o	2660 psf		Void Ratio	e_o	1.224	e_f	1.140
Preconsol. Press., P_c	8000 + psf		Saturation	S_o	102 %	S_f	108 %
Compression Index, C_c	0.193		Dry Density	γ_d	75.8pcf	γ_d	78.8 pcf
LL - -	PL - -	PI - -			G_s 2.70 (Assumed)		
Classification RED BROWN CLAYEY SILT (MH)			Source Boring 8 at 15.8				

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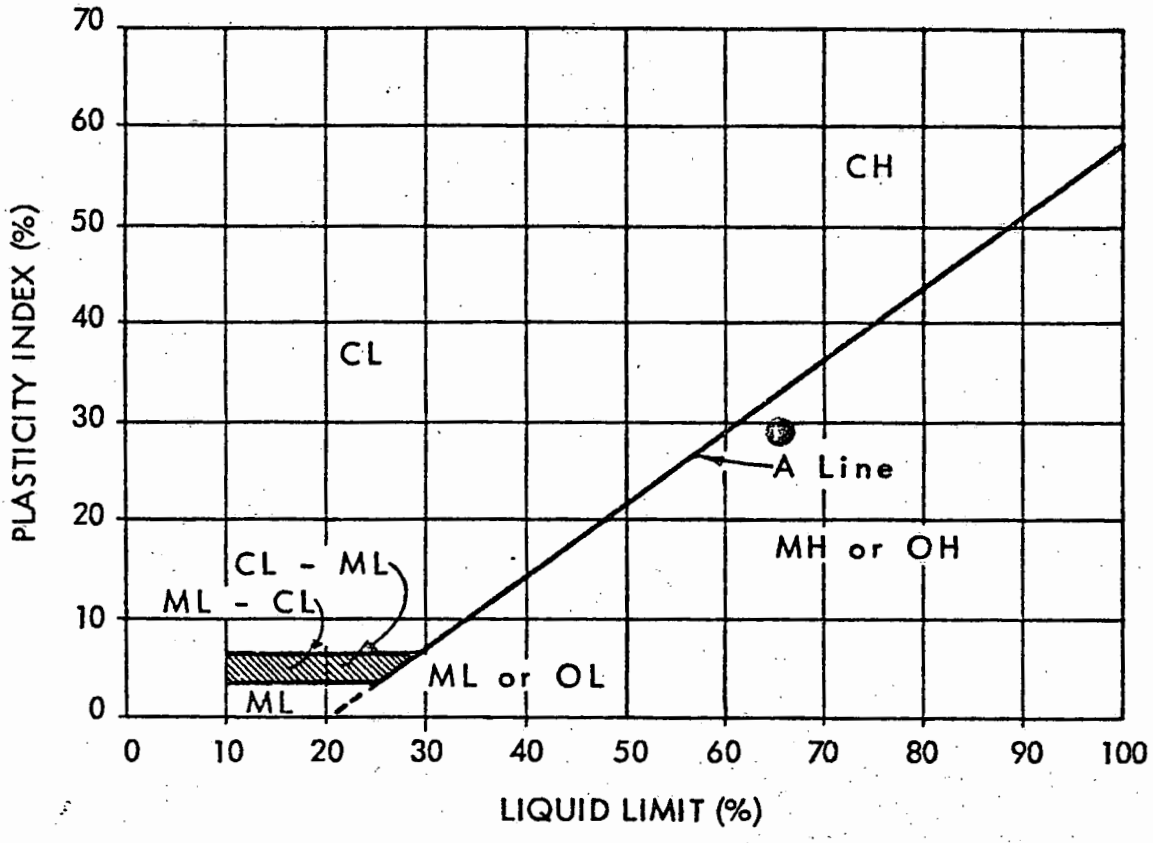
CONSOLIDATION TEST REPORT

Mililani Intermediate and High School, Second Increment

PLATE 10



Symbol	Classification and Source	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
●	RED CLAYEY SILT (MH) Boring 11 at 2.5'	65	35	29	- - - -

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PLASTICITY CHART

Mililani Intermediate and High School, Second Increment
Mililani Town, Oahu, Hawaii

PLATE 11